# Trends in Resource Management Needs and Issues: a Literature Review

## Report to the NOAA Coastal Services Center

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# 1 Executive Summary

As a preliminary step in assessing the current needs of coastal managers, we have reviewed recent and current literature that addresses the Coastal Services Center's thematic areas: Coastal and Ocean planning, Coastal Conservation, and Hazard Resilience.

## Issues

The primary ongoing issues of concern for coastal managers are land use planning and habit change and conservation. Water quality, while still a concern, has not been among the highest priorities in recent reports. Climate change and coastal hazards such as hurricanes and tsunamis, because of their impact on human well-being, are emerging as dominant issues.

## Needs

Scientific and social science information needs include matching data collection with management needs, improving access to data, ensuring currency and completeness of data sets, and utilizing GIS and remote sensing technology. Furthermore, managers require appropriate tools and resources to better understand, apply, and communicate the data available. The most prominent type of information needed is information on the human dimensions of ecosystems.

## Management practices

One significant development in costal management practice is that many managers are in the process of adopting ecosystem based management principles. The preeminent needs expressed by managers are better communication within the management community and greater inter-jurisdictional cooperation. Improved communication and collaboration could, in fact, resolve many data and resource access issues.

## Conclusions

There is a resounding need for coordination and communication across resource management entities. The Coastal Services Center's unique position could give it the opportunity to serve as a coordinating entity, particularly through its regional initiatives. The products and services that the Center provides are invaluable, and the Center can enhance them by working to connect their customers with each other.

# 2 Introduction

The ubiquity of human impacts on the marine ecosystem and the increase of human settlement in coastal areas present coastal resource managers with an array of challenges (Millennium Assessment 2005). Meeting these challenges requires knowledge of ecosystem components and processes, sufficient resources for research, and the ability to communicate scientific information effectively to decision makers and stakeholders.

This literature review provides an overview of current approaches to coastal resource management and identifies key gaps in the current body of available information. Rather than presenting a comprehensive synthesis of the current literature, we have selected representative publications and generated a gap analysis that can be used to focus future efforts. The surveys, needs assessments, and other publications we reviewed reveal the need to improve the way information is collected and handled, ranging from the selection types of data being tracked to the ways in which resulting information is analyzed and promulgated. Specific issues commonly cited include the need for more and better data collection, the need for tools that will enhance the usability of information collected, and the ability to better share data and findings with the public. The most prominent concerns, however, are the need for better communication and collaboration within the management community and the importance of including the human dimension of ecosystems in the data collection and analysis process.

# 3 Coastal and Resource Management

Most reports identified the need for integrated management, such as Ecosystem Based Management (EBM), as an overriding issue. Survey results indicate that many within the resource management community already use elements of EBM frequently (NOAA CSC 2008b).

## 3.1 Coastal and Resource Management Issues

The most commonly cited issues, in order of priority, are impacts on habitat, coastal-and-land- use planning, and water quality. Other frequently cited issues include harmful algal blooms, energy facility siting, and aquaculture. Indicators tracked by the EPA indicate the poorest condition in coastal habitat, sediment quality, and benthic condition (EPA 2008). Common concerns for all coastal management communities, and particularly for the Gulf of Mexico, are inaccessibility and incompatibility of technical data (NOAA CSC 2007). Scientific monitoring, analysis, and forecasting need to link changes in ecosystem services to human causes (NCCOS 2007); these needs should receive priority in the planning and implementation of the US Coastal and Ocean Observing System (USCOOS) (UHI 2004b).

### 3.1.1 Habitat

The habitat issues most commonly cited in reports and surveys are

- Habitat change

- Habitat use, loss, and degradation
- Habitat restoration and monitoring
- Habitat mapping
- Sediment quality and condition
- Erosion (NOAA CSC 1996; 1999; 2002b; 2006a; 2008; CSO 2004; UHI 2004b; EPA 2007; 2008; Heinz Center 2006; CICEET 2007; COST 2008)

One underlying theme is that effective management of these issues requires more and better information.

### 3.1.2 Coastal and Land Use Planning

While those in the Northeast Corridor and the Gulf of Mexico face the greatest pressures, coastal and land-use planners throughout the country are engaged with the following issues:

- Increasing coastal population
- Competition for land use
- Maintenance of public access to coastal areas
- Coastal development
- Watershed and land use planning (NOAA CSC 1996; 2002a; 2002b; 2006a; 2007; 2008a; UHI 2004b)

### 3.1.3 Water Quality

Water quality issues vary to some degree on a regional basis, with Gulf of Mexico stakeholders ranking it as especially important. Common issues include:

- Water quality monitoring
- Non-point source pollution
- Nutrient enrichment and reduction
- Water quality degradation in rivers and estuaries (NOAA CSC 1996; 2002b;2006a; 2007; 2008a; CSO 2004)

According to the EPA's National Coastal Condition Report, 57% of assessed resources have good water quality, whereas 34% are fair condition and 6% are in poor condition (EPA 2008). In addition, 37% of National Estuary Program (NEP) estuaries are in poor condition (regionally Puerto Rico is the worst, followed by the Northeast and Gulf Coast (EPA 2007).

### 3.1.4 Energy Facility Siting

Since 2001, new energy facilities have been proposed or permitted in most states with coastal zones, most prevalently in the Northeast, mid-Atlantic, Gulf and Great Lakes states. Given current energy use patterns, this trend is likely to continue.

Some examples of energy projects with coastal impacts include

- Proposed wind farms in MA

- In NJ, the Electric Discount and Energy Competition Act revises Coastal Management Rules to better address energy facility siting
- A CT program addresses energy facility siting in Long Island Sound
- Maine is reviewing acts and state policies relevant to alternative energy development activities (NOAA OCRM 2006).

### 3.1.5 Harmful Algal Blooms (HABs)

HABs can have negative impacts on public health, commercial fishing, recreation and tourism. The costs of monitoring and managing are also an issue (NOAA 2008a). There are efforts underway to develop predictive models of HABs. In the Gulf of Mexico, for example, NOAA incorporates information gathered for Beach Condition Reports in their HAB detection and forecasting system. In addition, NOAA publishes an HAB Bulletin to alert coastal communities about developing blooms and changes to blooms (NOAA CSC 2008g). Prospectively, the National Centers for Coastal Ocean Science Strategic Plan specifies the development of a multi-agency strategy to collect human dimensions research needed to reduce impacts of HABs. Research encompasses understanding ecosystem stressors resulting from human behavioral patterns, such as the proliferation of harmful algal species caused by sewage and waste water treatment (NCCOS 2007).

### 3.1.6 Aquaculture

Aquaculture has developed as a response to reduced catch levels and ecosystem impacts from resource harvesting, but presents its own array of ecosystem effects. Resource and coastal managers must now devote some level of planning to aquaculture (NOAA OCRM 2006). Aquaculture pens can have significant aesthetic and environmental impacts, which include rendering surrounding areas of the water column unusable for other activities. Programs that are successfully managing aquaculture include the Virginia Coastal Zone Management Program, which supported development of an industry-based best management practices, and the Rhode Island Coastal Resource Management Program (CRMP), which developed a comprehensive aquaculture management plan for the state's coastal waters. One issue in Rhode Island has been ornamental marine aquaculture (NOAA CSC 2008g).

### 3.1.7 Human Role in the Ecosystems

Human decision making, institutional strategies, and communication patterns can have deleterious ecosystem effects. In order to account for these effects appropriately, coastal managers need scientific monitoring, analysis, and forecasting regimens that show correlations between human activities and changes in ecosystem services. The environmental impacts of existing institutional approaches should be evaluated and those approaches may require modification or redesign (NCCOS 2007).

When working to restore declining ecosystem benefits, coastal and ocean managers should consider human dimensions as a component (NCCOS 2007). For example, mitigation measures can include

- directly modifying environmental systems (e.g., installing artificial coral reefs to provide essential fish habitat)
- reducing human impacts that cause ecosystem stress (e.g., regulating a fishery to prevent depletion of stocks)
- intervening with social drivers (e.g., providing education and financial assistance to promote agricultural practices that reduce nitrogen inputs)

In any management planning process, the consequences of each mitigation measure will need to be assessed and the trade-offs of ecosystem services associated with different mitigation measures will need to be evaluated (NCCOS 2007; CICEET 2007).

### 3.2 Science and Management Tools

In order to understand the connections between human impacts and ecosystem service changes, decision makers need decision support tools such as integrative ecosystem models (NCCOS 2007). Management support needs include partnerships among agencies, outreach and public relations, and increased access to and facility with information and technology (NOAA CSC 2002b).

Tools that provide information about system-wide processes include maps, predictive models and indicators. Maps and predictive models can illustrate the evolution of coastal features under various scenarios (CICEET 2007). Indicators provide information about existing and on-going conditions, help measure the performance of public policies and programs, and can reveal the need for changes in policies and programs. Monitoring indicators over time can help to determine whether problems are developing, whether action is desirable or necessary, what action might yield the best results, and how successful past actions have been (NRC 2000).

Special Area Management Plans (SAMPs) can serve as tools for addressing a wide range of issues, including

- Watershed imperviousness
- Non-point source pollution
- Dock and pier proliferation
- Limitations to public access
- Loss of open space
- Waterfront redevelopment
- Habitat loss and fragmentation
- Loss of aquifer recharge zones (NOAA OCRM 2006)

They can also deal with common governance issues such as

- Consistency in resource management and policy implementation
- Coordination among multiple management authorities and jurisdictions
- Comprehensiveness in approaches to planning

Examples of successful SAMPs include the Greenwich Bay (Rhode Island) SAMP, which employs an ecosystem approach to protecting and restoring the bay's water quality and habitats; and the Delaware Coastal Management Program's SAMP, which addresses imperviousness and regional drainage issues, non-point source pollution, loss of

wetlands, degradation of river vegetation, lost opportunities to create community open space, and economic redevelopment (NOAA OCRM 2006).

### 3.3 Coastal and Resource Management Needs

- Improved regional ocean governance structures (NOAA CSC 2008b).
- Coordination between management and science communities (CICEET 2007).
- Data showing the dynamics of environmental systems and changes in their functioning (NRC 2000).
- New ecological monitoring programs that permit comprehensive and consistent assessment of all of the nation's coastal resources (NCCR 2008).
- Training for managers, practitioners and stakeholders on
    - The complexities of systems (e.g. estuaries)
    - Existing relevant modeling efforts,
    - Identification of signs of decline,
    - Ways to be more proactive (NOAA CSC 2007).

### 3.4 Ecosystem Based Management

Human use, socio-economic impacts, and climate change must now be considered alongside longstanding issues of habitat conservation and water quality (COST 2008). Ecosystem based management (EBM) has been developed in response to this need. "EBM accounts for both ecological and socio-economic factors as well as their cumulative impacts on a management area. EBM provides for geographically specific, holistic resource management of habitats, species, and ecosystem level effects of resource use, such as food web impacts" (MRAG 2008).

As global awareness of EBM increases, so does the call for its local implementation (NOAA CSC 2008e). The Coastal Service Center's New England and Gulf of Mexico regional Needs Assessments both mention EBM. Several initiatives and programs in New England currently incorporate EBM at local and regional scales:

- Rhode Island's Special Area Management Plans
- Massachusetts Oceans Act
- Gulf of Maine Council on the Marine Environment
- Long Island Sound Study

These could serve as examples for other programs nationwide (NOAA CSC 2007; 2008a).

Reducing or eliminating the deleterious consequences of environmental degradation on human well-being requires decision makers to develop appropriate strategies and communication. This in turn requires adequate information on both ecosystem functions and human impacts on the ecosystems.

While EBM predicates that coastal managers make decisions based on the best extant information, there often exists a wealth of information that is not readily available to them. In other cases, researchers have not coordinated with decision makers, so the data

collected do not match the information needs of decision makers. Data and tools to support EBM need to include local, species-specific, and ecosystem level data along with accurate and verifiable predictive models and spatial tools (NOAA CSC 2008e). According to Surfrider's State of the Beach Report, data on coastal processes, water quality, and environmental impacts are more available than eight years ago, but there still exist many gaps and shortcomings. To track coastal health and evaluate indicator data, more comprehensive collection and interpretation of data is needed (Surfrider 2008).

### 3.4.1 Needs

In broadest terms, decision makers need integrative ecosystem models and other decision support tools to link ecosystem services with human impacts and responses (NCCCOS 2007). More specifically, needs range from clarification of fundamental terminology and data to interagency managerial practices.

Although the concepts of EBM are generally agreed upon, some specific definitions for EBM do vary among agencies and resource managers (NOAA CSC 2008b). Resource managers and other decision-makers need help coordinating and operationalizing the concept of EBM for day-to-day management; clear definitions would aid in this process (NOAA CSC 2007; EBM Tools Network 2007). Other needs include

- Financial and technical capital
- Political support for integrated management
- Clear management objectives
- Collaboration/cooperation between agencies
- Better communication of EBM principles to the public (NOAA CSC 2008a; NOAA CSC 2008b; EBM Tools Network 2007; NSGO 2008)

EBM requires sound scientific information, including

- Baseline data against which to compare subsequent data
- Research on ecosystem processes
- Relationships between impacts and coastal stressors
- Long term data sets on human and ecosystem health
- Integrated ocean observing systems
- Standards for data collection
- Indicators to track the state and health of the ecosystem and to evaluate the effectiveness of EBM

Managers also need better procedures for interpreting and understand the data in order to put the information to appropriate uses (NSGO 2008; EBM Tools Network 2007; NOAA CSC 2008b; NOAA CSC 2008d).

EBM Tools Network surveyed coastal marine managers about their needs for planning and implementing EBM. Respondents identified the following critical needs:

- Engaging community and stakeholder groups in decision making
- Developing methods for establishing multiple use marine zones

- Developing methods for implementing ecosystem approaches to fisheries management
- Advancing coastal land use practices by accounting for land-sea interactions in land use decisions
- Managing marine protected areas
- Conserving marine biodiversity (EBM Tools Network 2007)

# 4 Conservation Planning

Literature reviewed in this section has been selected in keeping with the Coastal Services Center aim to help set regional conservation priorities so as to make them useful at the local scale as well.

## 4.1 Conservation priorities

Conservation priorities include:

- Preserving water quality and habitat
- Thorough habitat mapping and classification
- Understanding and controlling the threat of exotic and invasive
- Protecting, inventorying, and monitoring historically and culturally significant resources
- Accounting for potential threats posed by climate change to conservation targets (e.g. sea level rise)
- Emphasizing the benefits and services (such as habitat and community resilience) that the conservation of coastal areas will provide (NOAA CSC 2002a; NOAA OCRM 2006; Donahue 2007; TNC 2008).

## 4.2 Conservation planning interests

Conservation planning interests expressed by EBM practitioners included

- Biodiversity conservation
- Marine protected area (MPA) management
- Marine zoning
- Fisheries management (EBM Tools Network 2007; TNC 2008).

Donahue (2007) notes that the loss of biodiversity affects the ecological integrity and economic viability of coastal areas; therefore, it is essential that management of coastal habitats results in ecosystem protection, ecosystem restoration, and sustainable use practices. Other needs include

- System-wide assessment of available information and needs
- Characterization of coastal habitat types
- Identification of stressors and associated impacts
- Documentation of change over time
- Development and implementation of methodologies to characterize habitat change
- Assessment of impacts
- Prioritization of restoration efforts (Donahue 2007).

### 4.3 Monitoring

An essential requirement for effective conservation is an environmental and program monitoring regimen for evaluating progress. While there are many criteria for evaluating indicators, the fundamental requirements are that they be understandable, quantifiable and broadly applicable (NRC 2000). The Coastal Zone Management Act (CZMA) has six broad issue areas under which performance measures should be organized:

- Government coordination and decision making
- Public access
- Coastal water quality
- Coastal habitat
- Coastal-dependent uses and community development
- Coastal hazards (GAO 2008)

The GAO notes weaknesses in NOAA's performance measurement system and periodic evaluations of states' coastal management programs which limit the agency's ability to determine the effectiveness of the National Coastal Zone Management Program. These weaknesses include

- Lack of independent information to assess program performance against performance goals
- Lack of measurable targets
- Lack of integrative information to assess progress at the national level
- Bias by program officials in the topics selected for NOAA's review

The primary needs for evaluation tools are measurable targets and a process that ensures the accuracy of performance measurement data (GAO 2008).

## 5 Coastal, Ocean and Land Use Planning

Coastal and Ocean Planning is the synthesis between conservation and management of coastal habitats and resources. It encompasses issues related to land use planning, climate change, marine spatial planning, effects of management decisions on ecological and socio-economic factors, and trade-offs between socio-economic benefits and environmental costs of development. Coastal, ocean and land use planning operates on both the regional scale, with an emphasis on coordination between agencies, organizations, and other stakeholders, and the local scale, with an emphasis on addressing specific needs, capacity, and limitations (NCCOS 2007; Desotelle Consulting et al. 2006a). One report reviewed identified a lack of understanding of the importance of watershed planning at the local level, reflecting the need for better communication with the public (Desotelle Consulting et al. 2006a). A Northern California Needs Assessment emphasized the fact that regional development plans should be site specific, because coastal and terrestrial areas have different needs and impacting factors (NRS 2006).

Planning for growth and land use in coastal areas is complicated and has been identified as a high priority issues among managers, particularly along the Gulf coast (NOAA CSC 2007). In 2008, the Center's publications treated many planning related topics, including:

- Comprehensive plans and visions for entire coastal areas
- Monitoring effects of dam removal

- Importance of state legislation with respect to endangered species
- Coastal management
- Beach grooming and beach fill
- Urban water trails and their function in connecting people with the environment
- Boundary designation for marine managed areas (NOAA CSC 2008e)

The Coastal States Organization (CSO) has noted that to support planning management, federal scientific research and monitoring programs need to be implemented and developed (2008). The GAO's performance areas for the CZMA, cited above in Conservation Planning, are also useful for monitoring coastal, ocean, and land-use planning.

One invaluable science tool for planning and development is a coastal and ocean observing system (UHI 2004a; EBM Tools Network 2007). The US Coastal and Ocean Observing System (USCOOS) could provide observations on both the local and the Large Marine Ecosystem (LME) scales. This system provides essential data for coastal models (such as storm surge models) and other applications valuable in planning (UHI 2004a).

## 5.1 Land Use Planning

Land use planning and habitat change are complicated by the need to balance environmental and human health with economic growth (UHI 2004a; 2004b; CSO 2004; CICEET 2006; NOAA CSC 2006). In the context of watershed plans and comprehensive land use plans, states have addressed environmental concerns with mechanisms such as specific use permits and local ordinances restricting growth and land use. Challenges like the downstream effects of upstream land use will, however, persist (NACo 2007). Decisions required for land use planning have profound effects on the environmental and economic sustainability of coastal areas. Conversely, changes in the ways humans use and value the land present on-going challenges for coastal managers (Donahue 2007). Land use planners must also recognize the risk of natural hazards and incorporate hazard mitigation strategies (NSTC 2005).

### 5.1.1 Loss of Public Access

In the past decade, loss of public access has emerged as a significant issue. The dwindling supply of undeveloped land has forced developers to focus on redevelopment projects, raising land values and promoting the conversion of previously public facilities, such as commercially-operated marinas, into condos and private marinas. In the redevelopment planning process, many states have not accounted for the loss of public access, and the resulting negative effects on both recreational users and commercial users, such as fishermen (NOAA OCRM 2006). States' responses include technical and financial assistance for revitalization and the appointment of public access authorities to inventory and prioritize public needs (NOAA OCRM 2006). Related to planning and redevelopment is the accompanying permitting and regulation process. This process is often confusing for homeowners and contractors because they do not receive clear guidance on the best practices for land use.

### 5.1.2 Cumulative and Secondary Impacts

In response to the need to manage cumulative and secondary impacts of development, (impacts that may be insignificant by themselves but become a problem when combined with all other development impacts in an area over time), North Carolina and South Carolina have developed regulations to supersede or revise existing requirements and New York has provided leadership, assistance, and funding for redevelopment and protection; these successes may serve as sound examples for managers in other coastal areas (NOAA OCRM 2006).

### 5.1.3 Research Needs

The highest ranked research needs for land use planning and habitat change are better understanding of cumulative impacts and multiple stressors (UHI 2004b). Additional research needs include

- determining appropriate thresholds for development
- gathering information to assess land use change and analyze trends
- acquiring additional technology to support research and information gathering (Donahue 2007)

Enhanced monitoring programs are also needed to assess land use change over time, characterize impacts of stressors, develop decision support tools to assess ecological and economic consequence of change, and establish thresholds based on monitoring, modeling, and related scientific information (Donahue 2007). A Heinz Center (2006) report identified landscape pattern/remote sensing analysis as a high priority data gap given the effects of suburban sprawl, forest patterns, and forest fragmentation on ecological condition.

### 5.1.4 Primary Hindrances

According to a 2006 survey, the primary hindrances to improving land use planning are lack of political will and inadequate resources (funding, staff, infrastructure) rather than the lack of science and technology (CICEET 2006). Other reports had similar findings, though science and technology needs do remain a priority (CICEET 2006; Desotelle Consulting et al. 2006b). The requirements for effective planning and management are coordination between entities, access to data and tools, and recognition of local level needs (Desotelle Consulting et al. 2006a).

### 5.1.5 Smart Growth

An emerging approach to land use planning, "Smart Growth," outlines principles and provides resources for communities to effectively plan for development. The goal is growth that is economically sound, friendly to the environment, and supportive of community livability. Smart growth incorporates the expertise both of developers and of environmentalists, and uses land cover data to gauge ecosystem trends and plan for the future (NOAA CSC 2008e). Acknowledging the need for effective land use planning, the National Sea Grant Program has designed a strategic goal to "support innovative research on land-use practices and building designs that promote energy and water conservation,

coastal-ocean related renewable energy technologies, and the creation of other tools to help communities grow in sustainable ways" (NOAA NSG 2008).

### 5.2 Erosion and Sediment Management

In the range of information reviewed, only one report specifically investigated erosion control, and identified the need for clear and available information on system-wide processes and hazards, including maps of erosion zones and rates. Numerous references, however, identified habitat use and degradation as an issue of concern without explicitly segregating out the subtopic of erosion and sediment management. In general, decision makers need better information about how different erosion control options affect regional resiliency and water quality (CICEET 2007).
The following specific needs are also noted in the literature:

- Development of predictive models to illustrate the evolution of coastal features under various scenarios.
- Improved permitting systems and regulations to help mitigate erosion. Currently, permitting systems that discourage non-structural erosion control often fail to discriminate between potential habitat impacts (e.g., adding "living shoreline" but losing subtidal bottom habitat).
- Better communication of the importance of economic drivers for erosion control policies. This includes quantification of the costs and benefits of non-structural erosion control techniques, and better integration with FEMA policies and insurance practices.
- Mitigation of coastal hazards created by erosion (CICEET 2007; NOAA OCRM 2006).

One report noted that many coastal states have been addressing dredging and sand management, including beneficial reuse and disposing of contaminated sediments (NOAA OCRM 2006).

## 6 Hazard Resilience

The resiliency of a community, or system, is its capacity to adapt to potential hazards in order to achieve and sustain a level of functioning and structure (NOAA CSC 2006b; LA Sea Grant 2009). Coastal communities are subject to hazards such as sea level rise, increased number and severity of coastal storms, risk of oil spills in select regions, and other natural and human hazards that have major implications on human safety along with the economic and environmental health of coastal areas. Management issues include community preparedness, management information needs, planning, training, and public communication and education.

The sources reviewed indicate that hazard planning and mitigation need to be improved. Despite concerted efforts by scientific and coastal management communities, there remains a strong need to increase community resilience to coastal hazards (NOAA CSC 2007; 2008a). While previous Center surveys identified the importance of hazard mitigation for coastal managers, the most recent survey (2006) gives greater priority to data and tools needs for hazard mitigation, including risk and vulnerability assessments

(NOAA CSC 1996; 1999; 2002; 2006). In a 2006 survey, all regions rank flooding, erosion and storm surge as highest level risks. Sea level rise is ranked as either a high or medium level risk. Regional variances in high risk issues include earth quakes for the US West Coast, tsunamis for the Pacific islands, and hurricanes for the Gulf of Mexico and Southeastern states (NOAA OCRM 2006). The Center's 2008 publications highlight the topic of coastal hazard resilience, presenting articles on

- Flooding and the creation of related observation and prediction systems
- The Massachusetts StormSmart Coasts website (launched in May 2008), which consolidates and simplifies information from around the U.S. on everything from hazard identification and mapping to legal information and funding
- The installation of tsunami warning signs as part of broader hazard education in Oregon
- The increasing importance of general tsunami awareness and mitigation
- Hurricane preparation and funding support as primary needs for Florida's preparedness (NOAA CSC 2008g)

## 6.1 Preparedness

Community preparedness is an essential element of hazard resiliency. Key preparedness tasks include

- Measuring and monitoring hazard resiliency
- Communicating with elected officials about hazard preparedness
- Communicating with the public about hazard preparedness
- Developing programs to mitigate impacts (NSTC 2005; NCCOS 2007; NOAA CSC 2007; Safford et al. 2006; NOAA CSC 2008a)

These tasks require state and territorial policies and initiatives devised for general coastal hazard mitigation (Rubinoff et al. 2008).

Recently implemented coastal hazard management initiatives include

- Digital update of shoreline changes in Maryland
- A coastal erosion management study that includes policy alternatives to minimize the adverse effects for Puget Sound
- Hazard mitigation plans addressing hurricanes, earthquakes, tsunamis, floods, wildfires and lava flows for all four counties within the state of Hawai'i (NOAA OCRM 2006)

Michigan, the San Francisco Bay area of California, Texas, and Ohio are among the states that have developed strategies for coastal hazard management. Strategies include research on human-induced climate change, vulnerability assessments, and habitat restoration (NOAA OCRM 2006).

Although local governments can play a valuable role in management planning and communicating with the public, there is a general lack of planning capacity and resources at the local level. One exception is involvement of local governments in development decisions in New England (NOAA CSC 2008a). Federal and regional programs, such as those currently operating through agencies like NOAA and the US Army Corps of

Engineers typically provide more robust, focused coastal hazard mitigation (NOAA CSC 2008a).

Although communities continue to be challenged by disaster preparation, response, and recovery, there has been progress in the amount and availability of information regarding coastal hazards and in the application of science and technology to hazard mitigation. In particular, information collection and the science tools to process that information have improved (NSTC 2005; Surfrider 2008).

Recently, several decision support tools to promote hazard resilience have been developed:

- Flood plain management tools
- Risk assessment tools to analyze potential losses from floods, hurricane winds, and earthquakes
- Tools to assess the vulnerability of communities to the potential impacts of floods, hurricane winds, and earthquakes
- Tools to predict storm surge heights and wind speeds from hurricanes
- Tools that use a set of indicators to explore differences in social vulnerability among various locations (Safford et al. 2006; CSO 2008)

## 6.2 Information Needs

At-risk and hazard resilient communities should be able to recognize and understand relevant hazards, know when an event is imminent, and have actions in place so that individuals are safe and there is minimum disruption to life and economy after an event (NSTC 2005). For communities to achieve this level of preparedness, there need to be

- A framework providing access to and usability of information
- Coordination between coastal practitioners
- tools and communication in place along with sufficient capacity to serve these needs
- Coastal hazard monitoring programs
- Methodologies to improve the development, application, and evaluation of coastal hazard programs (Donahue 2007; NOAA CSC 2006a; 2007; 2008a; UHI 2004b; Safford et al. 2006; COST 2008)

Risk and vulnerability assessments were identified by the Coastal States Organization as the top research need for coastal hazards management (CSO 2008). This type of assessment applies specifically to hazard resilience, and more generally to coastal management as a whole. Risk and vulnerability assessments need to better assess the vulnerability of coastal infrastructure and critical facilities to sea-level rise, erosion, flooding, and storm surge (NSTC 2005; NOAA CSC 2007; 2008a).

Recognizing the information needs of coastal managers related to hazards, the National Science and Technology Council has called for a framework that prioritizes hazard-related Federal investments in science and technology (NSTC 2005), and the National Sea Grant Program, in its current strategic plan, recommends improving research on

hazard-related risks and making hazard-related information more available and useful (NOAA NSG 2008).

Coastal managers need more information in order to anticipate, prevent, and mitigate coastal hazards at every scale, from short-term, localized events, such as extreme storms, to long-term global phenomena such as climate change and sea level rise (Donahue 2007). Primary information needs include

- Collecting baseline data
- Understanding how societal values and critical infrastructure are affected by changes in ecosystem services caused by natural disasters
- Increasing information on the human dimensions of ecosystems
- Improving public awareness
- Providing incentives to adopt mitigation measures
- Showing the economic connections between habitat and mitigation, particularly in hard hit areas (NSTC 2005; Donahue 2007; NCCOS 2007; NOAA CSC 2007; NOAA CSC 2008a)

According to a survey of coastal counties, improved access to data sets and tools for disaster management is one of the most important information needs (NACo 2007).

Within the Coastal Services Center, the Gulf of Mexico and Hawai'i and Pacific Islands have regional activities focused on enhancing coastal community resilience through access to information, tools and ongoing assessments, though these activities are not primary projects in other regions.

### 6.3 Science Tool Needs

While professional resource managers have a good amount of knowledge about some coastal hazards, such as storm surge, elected officials and the public tend to have little knowledge, highlighting the need to translate the information available (Safford et al. 2006). Elements of this communication process include

- Developing or modifying models for range of coastal hazard challenges they confront
- Improving information regarding hazard resilience and post-disaster planning
- Improving training for hazard resilience and post-disaster planning
- Developing forecasting and decision support tools
- Communicating model results to the public more effectively (Safford et al. 2006; Donahue 2007; NOAA CSC 2007; NCCOS 2007)

To foster public action, managers need to communicate with the public about how and where to access community services (NOAA CSC 2007). Visualization tools can help managers communicate the risks associated with storm events and better prepare communities for hazardous events (NSTC 2005; NOAA CSC 2008a; NOAA NSG 2008).

While risk-based analyses are extremely valuable to resource managers, improved risk communication can facilitate decision making when conflicting information and perspectives exist (CICEET 2007; NOAA CSC 2008a). In any event, appropriate mitigation planning will be strengthened through

- Discussion of appropriate and realistic levels of resilience for different areas
- Collection of information
- Risk assessment
- Monitoring programs
- Effective tools and communication to address the needs of decision makers and stakeholders (NSTC 2005; Safford et al. 2006; CICEET 2007; Donahue 2007; NCCOS 2007; NOAA CSC 2007; NOAA CSC 2008a; NOAA NSG 2008)

### 6.4 Need for Coordination

To make hazard-related data and data-derived products available and useful during crisis events, community managers need to work with larger agencies, such as NOAA's National Weather Service and the National Ocean Service, regional ocean observation systems, etc. (NOAA NSG 2008). By coordinating with larger programs (i.e. NOAA Climate Change Program) and other public and private sector organizations, managers can improve community resilience through education programs about climate-related effects, hazardous events, and human safety (NOAA NSG 2008).

## 7 Climate Change

Climate change is among the most important issue for natural resource managers (NERRS 2008). Sea level rise and hazards, especially the increasing frequency and magnitude of coastal storms, have considerable effect on coastal ecosystems and must be appropriately considered in management decisions (NACo 2007; TNC 2008; NOAA CSC 2008b).

### 7.1 Managing Climate Change: Accomplishments

State governments are beginning to implement specific policies and strategies to encourage adaptation to climate change impacts:

- Establishing public infrastructure siting policies
- Including effects of climate change in site-level project planning
- Modifying wetland conservation and restoration policies
- Increasing shoreline setbacks
- Increasing "free board" (additional height) above Base Flood Elevation
- Promoting alternatives to shoreline "armoring" (controlling shore erosion with hardened structures like bulkheads, concrete walls, etc.)
- Encouraging the consideration of climate change impacts in state and local planning efforts
- Developing GIS-based decision-support and visualization tools
- Supporting outreach and extension activities, often through partnerships with NERRS or Sea Grants (CSO 2007)

Additionally, eleven states or territories have created working groups, commissions or committees on the issues of sea level rise. Nine states and territories have implemented outreach campaigns on the subject and 17 have information suitable for guiding decision makers. Fifteen states have plans, strategies or recommendations for action; although

only seven have implemented policy or regulation (Rubinoff et al. 2008). The National Centers for Coastal Ocean Science (NCCOS) has a science program that currently focuses on changes in the structure and function of environmental systems influenced by stressors such as climate change and extreme natural events. Systems being studied include national marine sanctuaries, coral reefs, coastal habitats, oceans, and estuaries (NCCOS 2007).

## 7.2 Managing Climate Change: Goals and Needs

Attempts to elaborate needs and appropriate goals for managing climate change effects are constrained by a general lack of knowledge: to plan for potential impacts, more research is needed (NOAA CSC 2002a). With that caveat, however, some general goals and more specific needs for addressing climate change have been identified. The National Estuarine Research Reserve System (NERRS) has established three climate change related goals for their program:

- Contributing to the scientific understanding of climate change and monitoring ecosystem changes
- Assessing climate change impacts on human and estuarine ecosystem communities (including the vulnerability of these communities and their capacity for adaptation and mitigation)
- Providing educational opportunities and training related to the effects of climate change to increase public awareness and foster behavior change (NERRS 2008)

These goals have been echoed by NCCOS (2007), and additionally, NCCOS has stated a need for interdisciplinary research and research at the regional or sectoral to analyze the response of human and natural systems to multiple stresses.

On a broad scale, state level needs include

- Development of uniform methods of modeling shoreline changes associated with varying sea level rise projections
- Generalized projections comparing the costs of response options, and the consequences of taking no action
- Information on the effects of sea level rise on frequency and volumetric requirements for beach nourishment; and the feasibility of using artificial sediment supplies to "nourish" coastal wetlands (CSO 2007)

On a finer scale, localized climate science is needed to support community level planning (NOAA CSC 2008a). For example, The National Association of Counties (NACo 2007) reported that coastal counties are concerned about both planning for resettlement absorption in the event of evacuation from nearby counties and gauging the urgency of local response planning.

Some in the management community feel that the measures in place today are inadequate to address increasing rates of sea level rise and other impacts of future climate change. New adaptation strategies should be developed to meet the challenges of accelerated change (Rubinoff et al. 2008). Some challenges to addressing the accelerated change include

- Meeting the information needs for adequate management and protection

- Obtaining the resources needed to deal with such a widespread, large-scale issue
- Mediating legal and regulatory concerns
- Deciding whether populations should be working in areas vulnerable to sea-level rise
- Preventing actions by coastal residents and governments that exacerbate the problem (e.g. building sea walls) (TNC 2008)

# 8 Communication and Outreach Needs

One major role of resource managers is to manage information: Not only do they need to receive and process information from the researchers, but they also need to make sure appropriate information is communicated to the general public through outreach activities. There is clearly a need for outreach on topics like land use planning and hazard resilience, whose relevance to human well-being is obvious; however, managers also need to communicate how human activities can affect ecosystems in ways that diminish the ecosystem services humans depend on. The general needs associated with communication and outreach such as effective leadership are examined in this section, along with tools and resources for providing better awareness and education.

Because effective resource management requires effective communication, it is imperative that managers be aware of and monitor for potential barriers affecting communication. Barriers to effective communication; include:

- Insufficient communication among scientists, resource managers, and citizens
- Language barriers
- Poor or non-existent relationships between scientists and resource managers
- Rapidly expanding information technology and data sharing requirements

To address these problems

- Scientists need to communicate in language readily understandable by managers and the public.
- Scientists and resource managers need to strengthen relationships by developing shared research questions to generate knowledge applicable to management issues.
- Scientists and managers must be mindful that the overwhelming pace and increasing ease of information exchange can become unwieldy and bring into question the accuracy and credibility of information (UHI 2004c).

To streamline information management and planning, managers should enlist communication specialists to advise, assist, and directly interact with stakeholder groups to improve coordination, communication techniques, and overall understanding of activities planned and implemented (NOAA CSC 2002a; NOAA NSG 2008).

## 8.1 Awareness and Education

Communication and outreach efforts are generally designed to increase awareness of information, products, or services (NOAA CSC 2002a; 2007). An integral yet challenging phase in the communication and outreach process is disseminating information and generating awareness of the information's existence (NSGO 2008;

Desotelle Consulting et al. 2006a). Transferring the appropriate information, while avoiding such barriers to effective communication as information overload, will often require innovative information management techniques (NOAA CSC 2007). Technical training in effective communication may be necessary (Safford et al. 2006; UHI 2004c). In order to foster public ecological literacy, managers need to develop outreach and education strategies that teach about the human dimension of ecosystems and the role it plays in resource management decision making (NCCOS 2007).

Several successful approaches to communication and outreach are cited in the literature reviewed. One effective manner of communicating information is through sharing success stories that can be applied to other coastal decision making exercises (NOAA CSC 2007). The NOAA Coastal Services Center conducted a survey in the Gulf of Mexico where best practices for communication and outreach were evaluated; this identified that multiple methods should be pursued for effective communication.

Furthermore, the public communication of risk, in particular, needs to be flexible and adaptable (NOAA CSC 2007). The Urban Harbors Institute found that broader audiences can be reached by communicating information in various venues and that increasing information sharing opportunities can bridge the knowledge gap between science and policy (UHI 2004c). Several innovative communication and outreach methods have been used, including blogging, mobile classrooms, workshops, and organizing tours through natural environments with trained operators (CSO 2006; NOAA CSC 2008b).

Monitoring the effectiveness of outreach efforts can be achieved through developing strategic timelines, and through incorporating short-, mid-, and long-term outreach goals (NOAA CSC 2008b). There are also many tools, datasets, and resources available that could be used to facilitate communication of complex information, including various spatial tools for mapping and analysis tools for evaluating data (NOAA CSC 2002a; NACo 2007).

Specific topic areas in which public knowledge gaps have been identified include

- Issues related to marine conservation
- Marine Protection Areas
- Ocean processes
- General concepts in ecology (NOAA CSC 2002a; 2007)

Translation of scientific language into usable and understandable terms has also been identified as an area where education would assist (NOAA CSC 2007). There is also a knowledge gap around the intersection of knowledge and policy and the interconnectedness between activities on land and on sea (NOAA CSC 2007; 2008b).

### 8.2 Needs

In general better models are needed for compiling and communicating information because current tools are often not well understood by the general public (NOAA CSC 2007). Information management and dissemination are integral to effective communication. Information overload can be overcome through effective data

management and dissemination tools (NOAA CSC 2007). Improved communication would increase the public's understanding of the difference between protection and restoration efforts (NOAA CSC 2007).

Because managers and scientists are not generally trained communicators and are often busy with other tasks, dedicated communication specialists are needed to covey research and management information to the general public (NOAA CSC 2002a). Such specialists could also train staff members in effective communication (Safford et al. 2006).

Another identified need is enhanced communication across jurisdictional boundaries at all levels of government (federal, state, regional, local, and community). Inter-jurisdictional communication would promote more efficient resource use, alignment of goals, and improved public understanding of planning and implementation approaches (Desotelle Consulting et al. 2006a; 2006b; Safford et al. 2006; NOAA CSC 2008a). Enhanced communication does require additional funding, staff resources, dedication, and coordination (Desotelle Consulting et al. 2006b).

Outreach activities and efforts, ideally aimed at broader audience, often improve the effectiveness of communication. The use of specialists can enhance the effectiveness of outreach activities (NOAA NSG 2008; NOAA CSC 2007). Targets for outreach efforts should include

- Specific scientific topics
- Increased awareness of products and services available
- Awareness of planning and implementation activities underway
- Improving stewardship of marine resources (NERRS 2006; NRS 2006)

Leadership is a core element of any organizational communication strategy. Effective leadership is required for coordination of efforts, implementation of commonly developed priorities, and efficient use of resources (Desotelle Consulting et al. 2006a). Training may be required to develop strong leaders who will work toward developing and following through with implementation of an agreed upon vision or course of action (Desotelle Consulting et al. 2006a; Safford et al. 2006). Resource managers should engage communities, identify natural community leaders, and capitalize on the existing networks to disseminate information (Safford et al. 2006; NOAA CSC 2007; NOAA NSG 2008). Strengthening existing networks and collaborating within them often allows for information to be communicated through established and familiar pathways.

# 9 Stakeholder Input

Because managers need to account for the interests of all users and evaluate trade-offs, stakeholder engagement is an essential aspect of any sustainable management plan. Stakeholder input puts decision making into relevant contexts by incorporating the needs and interests of those groups and individuals that will be directly impacted by the management decisions (NCCOS 2007; Gray 2008). Stakeholder involvement facilitates defining and prioritizing activities, introduces innovation and creativity into planning and

implementation processes and moves toward a shared vision for future planning and management endeavors (NCCOS 2007; NOAA NSG 2008).

Stakeholder involvement is especially crucial to ecosystem based management (EBM) as humans are an integral component of the ecosystem as a whole (NERRS 2006; NOAA CSC 2008e). Formal channels for stakeholder involvement are incorporated into EBM planning exercises and are necessary to ensure that sustained meaningful stakeholder input is gathered (EBM Tools Network 2007).

### 9.1 Stakeholder Consultation Methods

Meetings and interviews have traditionally been used as means of gathering stakeholder input, but regardless of technique used, the establishment of formal channels of stakeholder involvement is necessary (NRS 2006; NOAA CSC 2008a). Ensuring inclusive, diverse stakeholder input in a given activity requires involving stakeholders early and often in all areas of strategic planning, monitoring and assessment of programs, and dissemination of information at the completion of the activity (NCCOS 2007; NOAA CSC 2007; CICEET 2007). To sustain this level of involvement, managers need to go beyond traditional strategies and incorporate broader stakeholder groups through creative outreach activities (NOAA CSC 2002a).

Involving stakeholders often requires building trust, a process that can be enhanced through collaboration (NOAA CSC 2008a). Non-governmental organizations (NGOs) can serve as effective liaisons for ensuring stakeholder input (NACo 2007). For example, the Massachusetts Ocean Partnership, a public-private partnership, facilitates information exchange among stakeholders in developing the Massachusetts Ocean Plan.

Whatever the variety of methods employed to involve stakeholders, “lessons learned” briefings can help groups improve their stakeholder involvement processes (NOAA CSC 2002a).

## 10 Social Science Needs

Social sciences such as economics, sociology, political science, and geography can help managers better understand and work with the human dimensions of ecosystems. Research in these disciplines can help elucidate the human role in the ecosystem, clarify valuation of ecosystem services for human health and economies, and develop approaches to coordination and collaboration among stakeholders.

### 10.1 Coordination

To gather and maintain necessary socioeconomic information, capacity needs to be increased across all management sectors and efforts need to be coordinated (EBM Tools Network 2007). Coordination is challenging because of the many entities and disciplines that must attempt to integrate and manage data (NOAA CSC 2007). Examples of coordination efforts requiring social science information include

- Warning systems for hazards

- Systems for tracking and monitoring cumulative impacts
- Watershed planning activities (NSTC 2005; UHI 2004b; Desotelle Consulting et al. 2006a)

Because the political process requires engagement with governments at the local, state, and federal levels, current social science knowledge and data would aid in making political decisions relevant to the communities they affect (NOAA CSC 2008a).

## 10.2 Information Needs

### 10.2.1 Uses

Managers need to take into account affected populations. Sociological information on the values, ethics, politics, and traditional ecological knowledge of affected communities needs to be incorporated with scientific information used in decision making (UHI 2004c). Population density information affects both funding/grant levels to communities and calculations of population condition scores (EPA 2007; GAO 2008).

Informed by social science, resource managers may be better able to communicate the connections between people and place, and thereby foster greater stewardship of the ecosystem (NRS 2006). Current and available public access data for creating accurate guides and maps can facilitate public enjoyment of marine and coastal resources, reinforcing a sense of connection and stewardship important for adding value to natural resources (NOAA CSC 2007; EPA 2008; Surfrider 2008). Outreach activities aimed at increasing awareness and understanding of the value of the marine environment, both in economic and non-economic terms, would help the general public better understand management decisions concerning ecosystem impacts on public health and hazard resilience (Surfrider 2008; NSTC 2005).

Social science approaches can also help managers adapt when technical data are poor or uncertain. Understanding human behavior and the human dimensions of ecosystems can help predict outcomes of situations, thereby providing valuable information to decision makers (Gray 2008; UHI 2004c). Furthermore, predictive modeling that incorporates current social science metrics is useful in creating economic models of consequence, resilience, and resistance (NOAA CSC 2007).

### 10.2.2 Gaps

Incorporating social science information into outreach and education programs requires training and technical assistance (Safford et al. 2006). Current and maintained demographic data sets are often either incomplete or entirely missing. The entire body of such data needs to be updated from its current fragmented state. Improving demographic data sets would reduce duplication of effort by multiple agencies, which currently collect similar information (NSGIC 2008a; 2008b). Updated social science data and tools would aid in sustainable coastal development (NOAA CSC 2007). For example, current EBM efforts are hampered by the lack of information on human uses of the ecosystem, and by the lack of resources and coordination to acquire those data (EBM Tools Network 2007).

Updating and maintaining social science informational databases will benefit any activities requiring economic information and tools (NOAA CSC 2008a).

### 10.3 Economic Information

Of the various social science information needs, information on the economic value of ecosystems appears to be the most pressing. Clearly communicating the value of natural resources in economic terms allows diverse audiences to place tangible value and meaning on ecosystem services and to understand the reasoning behind management decisions (NOAA CSC 2002a; 2007; 2008a; NERRS 2006; NOAA NSG 2008; NSTC 2005).

Economic modeling of the cost-benefit ratios of various resource uses can inform management decision making and help shape future development scenarios (NOAA CSC 2007). By providing cost-benefit analyses, risk analyses, and prediction capabilities, economic modeling can be used to enhance communications, trust, and understanding within a community and promote 'risk-wise' behavior (NSTC 2005; NOAA CSC 2008a). Explaining resource-planning, implementation, and mitigation efforts in economic terms can make the costs and benefits more transparent and also create incentives for funding coastal conservation (NRS 2006).

## 11 Methods of Information Collection

The literature we reviewed uses a variety of methods for information collection. A number of reports evaluate programs or summarize existing efforts using information collected via desk studies; these have not been included in this section. In this section, we address the methods used to collect information that identify needs and trends among managers, scientists, and the public. This summary is intended to serve as the first cut to identify which literature reflects information collection methods are worth further investigation in the meta-analysis that will follow this literature review and to identify methods to employ in the Center's next customer and program evaluation survey.

The most thorough information collection methodology, which uses a stepped approach, was done for needs assessments. In the first step, steering committees identify the targeted audience, help choose the literature to be reviewed, and create a prospective list of survey respondents. The literature review then establishes a list of issues and needs. Subsequently, information pertaining to that list is expanded and refined through interviews, focus groups, and surveys (Desotelle Consulting et al. 2006a; 2006b; NOAA CSC 2007; 2008a; Donahue 2007; NRC 2004; NOAA 2008b). In general, this format successfully the identified priority issues and the needs of the targeted communities. It also provided regional and national comparisons when available. Tools such as phone interviews, mail and internet surveys, often in combination with literature reviews were used to refine needs and issues of the identified targeted audience (NOAA CSC 1996; 1999; 2002b; 2006b; 2008d; CSO 2004; UHI 2004a; 2004b; 2004c; MCPI 2005; EBM Tools Network 2007; NRS 2006; NACo 2007; TNC 2008; COST 2008; NOAA 2008). Other information collection methods included task forces, subcommittee meetings, phone calls, journals, the internet, email, newsletters, meetings, video conferencing,

conferences, workshops, advisory committees, and working groups for information exchange (NSTC 2005; MPANA 2002; CICEET 2007; Weisberg et al. 2007; COST 2008).

Regardless of the particular information collection method, researchers need to identify the appropriate audience, develop well-targeted questions, and provide an incentive for replying. Researchers should minimize the time cost of surveys, because resource managers are already challenged by the time commitments of their jobs. Response rate can be improved by having a list of respondents involved with the subject matter and already familiar with the Center and/or resource management issues. After receiving responses, researchers should follow up by letting participants know how and where their input will be used.

# 12 Data and Information Concerns

In 1996, The Coastal Services Center identified data needs as one of main obstacles to coastal management (NOAA CSC 1996). Since then, many states have directed more resources towards the collection and assessment of ocean and Great Lakes resource baseline data (NOAA OCRM 2006). Nevertheless, to improve planning, management, and decision making, better data availability and management are necessary. Although information management issues are mentioned under individual topics, this section will focus specifically on gaps in data, access issues, and usability needs, as well as the uses and needs of remote sensing and GIS data.

The studies we reviewed included research reports, which not only discuss the data collected, but also note what should have been collected; strategic plans, in which information management is integral to achieving stated goals; and needs assessments, which often represent "wish lists" from which managers would work in a best case scenario. Needs range from the raw data to the tools to translate data and the means to communicate the information. A primary obstacle to fulfilling information needs is resource availability (staff, training, time, funding) (NOAA CSC 2007; 2008e; NACo 2007; CSO 2008; Desotelle Consulting et al. 2006b). This section will characterize general trends in information needs while noting that agencies and regions have their own 'wish lists'. While not every data need can be fulfilled at once, working towards filling the gaps will improve the nation's capacity to report at the national scale on ecosystem conditions and trends (Heinz Center 2006).

## 12.1 Data Uses and Needs

### 12.1.1 Scientific Data

Although there exist tremendous volumes of information for management decisions, scientific and management communities create new questions and are pressed to collect more information as technology and our understanding of the interactions between factors improves.

### 12.1.2 Information Types

Types of information that are being used more frequently by agencies at the local, state, and regional levels include

- Habitat mapping
- Habitat classification
- Bathymetry and elevation data
- Remote sensing data
- Species-level data
- Studies of land use changes over time
- Vulnerability assessments
- Assessments of cumulative effects

While these data are available to some degree, the means to improve data collection and interpretation would benefit the coastal management community. Managers need to understand connections between habitat areas, stressors, and potential impacts, and be able to describe temporal trends and changes in land use, coastal habitats, and habitat quality (CSO 1999; 2004; NRC 2000; NOAA CSC 2002a; 2007; 2008a; NRC 2004; NSTC 2005; Desotelle Consulting et al. 2006b; NERRS 2006; 2008; NRS 2006; NOAA OCRM 2006; NOAA 2008; TNC 2008). Information is most beneficial when it seamlessly transitions boundaries, such as inshore to offshore, or across political and jurisdictional boundaries (NRC 2004; NOAA CSC 2007).

#### *12.1.2.1 Habitat and Land Use*

Resource managers have identified the need for additional information on habitat and land use. Understanding land use and planning its management is a common concern among resource managers, but there remain considerable gaps in relevant human use and habitat data, including

- Data pertaining to land use change
- Landscape pattern/remote sensing
- Land cover analysis
- Aerial satellite imagery
- Conservation of biodiversity
- Critical habitat boundary definition (especially in the Gulf of Mexico)
- Public access
- Water quality and availability
- Ecosystem function
- Impact analysis
- Hazard resilience and
- Human use assessments (CSO 2004; UHI 2004a; NSTC 2005; Heinz Center 2006; NERRS 2006; NOAA OCRM 2006; CICEET 2007; EBM Tools Network 2007; NOAA CSC 2007; TNC 2008; NOAA 2008; NOAA NSG 2008)

An important related issue is the high cost associated with obtaining data (Heinz Center 2006).

*12.1.2.2 Climate Change*

Addressing the emerging issue of climate change will require concerted data collection and research efforts (CSO 2007; NERRS 2008; NOAA 2008; TNC 2008). Managers need more information to deal with climate change related hazards and predicted sea level rise (NOAA CSC 2008a). A 2007 survey of the National Association of Counties indicated the need for new and improved data sets on

- Sedimentation
- Septic sites
- Bathymetry
- Flooding
- Impervious surface areas
- Federal lands data that indicates which agencies own which lands

Data interpretation needs include integration of flooding models with the built environment, better understanding of the limitations of datasets, and applicability of resolution at local levels (NACo 2007). For all of these data types, baseline data and evaluation metrics (i.e. indicators) also need to be established, which will require considerable coordination among entities (NRC 2000, NSTC 2005). Given limited resources, identifying and collecting performance measurement data is also a challenge, and will require an investment of additional resources for staff, training, equipment, and data management by NOAA and coastal states (CSO 2008).

12.1.3 Socioeconomic Data Needs

Managers' primary socio-economic data needs are for economic and vulnerability assessments that address the impacts of human land-and-water-based activities on nearshore marine ecosystems.

Multiple reports identified the need for focused economic valuation studies describing the value of resources and the economic impact of various activities on those resources (NOAA CSC 2002a; 2007; NERRS 2006; NOAA NSG 2008). In particular, research on the functionality of restored habitats would be beneficial (NOAA CSC 2007).

Nationally, managers would benefit from improved risk and vulnerability assessments and the tools to interpret those results and communicate them to the public. This need is particularly pronounced in the Gulf of Mexico (NOAA CSC 2007).

## 12.2 Access

Despite the continued need for more data in many areas, most states acknowledge that there is already an enormous amount of existing data. The data, however, are difficult to compare among states or on a national basis, because individual states use a variety of approaches for data collection and evaluation (i.e. of water quality) (Desotelle Consulting et al. 2006a; 2006b; COST 2008; EPA 2007; 2008). As a result, state and local officials have more difficulty accessing available data in a timely manner (NOAA CSC 2002b).

The main issue of accessing existing data can be at least partly remedied by improved coordination and communication between managers, decision makers, stakeholders, and others. Data access could be considerably improved by enhancing regional and national databases and data inventory networks, or "clearinghouses," with search mechanisms and tools to facilitate data contributions by local entities (NOAA CSC 2002a; 2007; Desotelle Consulting 2006b; CSO 2007).

## 12.3 Usability

Beyond the need for specific data sets, resource managers have called for improved access to, knowledge of, and training for application of data (NOAA CSC 2007). Data, models, and decision support tools can be put to many uses, but in general, they should be used to support EBM and help to improve community resilience (NOAA CSC 2007; EBM Tools Network 2007; NOAA 2008b). Some of the most relevant and applicable uses are

- Mapping
- Inventory
- Monitoring
- Ecological application
- Permitting
- Impact assessment (NOAA CSC 1996)

Across the board, managers also need improved models and decision-support tools, especially ones that can make multiple issues and types of data readily understandable (NOAA CSC 2002a; 2002b; 2006a; 2007; 2008; UHI 2004b; CICEET 2006; Desotelle Consulting et al. 2006b; Safford et al. 2006; EBM Tools Network 2007; COST 2008; NOAA 2008; NACo 2008). Raw data without the tools to analyze and apply them to management are irrelevant (NOAA CSC 2007). Additional needs include

- Tools to monitor longitudinal change
- Enhanced understanding of different habitat functions within the greater ecosystem
- Impacts of different anthropogenic and natural activities on coastal waters and habitats (NOAA CSC 2007)

### 12.3.1 Obstacles to Application

One of the biggest challenges to resource managers is figuring out how to use and apply data once they have been collected (NOAA CSC 2002b). Delivery and usability of the data is as important as the initial development of information. Unfortunately, research programs often collect and produce vast quantities of data that are never used to inform management or planning decisions because of a lack of financial and human resources, a lack of understanding of the data, or a lack of awareness that the data exist (Desotelle Consulting et al. 2006a; 2006b; Donahue 2007).

Weisberg et al. (2007) identified the primary obstacle to the application of research as the lack in coordination among entities at every step of the process. The limiting factor in transitioning research to applications is not a lack of information, but the need for a

supportive institutional culture, one that fosters sustained collaboration between information producers and information users.

An additional obstacle to usability is the inconsistency and varying reliability of data. Many states report their data differently; some submit precise numbers to NOAA while others submit estimates. When agencies are relying on external data collection sources, those data may be unreliable. There should be a consistent performance measurement system in use with a process to validate both quantitative and qualitative data sets (GAO 2008).

A third obstacle to appropriate application of data is that the end-users who would most benefit from the data don't know how to employ the tools to access it. Resource managers in the Gulf of Mexico and elsewhere have called for improved outreach, training, and technical assistance to ensure that data and tools are accessed and applied on the ground (NOAA CSC 2007). Tools and technical know-how are particularly lacking at the local level. These government entities need the technology and expertise to utilize data layers in decision making (Desotelle Consulting et al. 2006a; 2006b; NOAA CSC 2007; COST 2008). One Coastal Services Center study estimated that 80% of organizations need some sort of training about EBM and the tools used to implement it (NOAA CSC 2008e). Increased awareness of the capabilities of science tools and training in their use is essential to build confidence in decision making (NOAA OCRM 2006; EBM Tools Network 2007; NERRS 2006; UHI 2004c).

## 12.4 Remote Sensing and GIS

Since remote sensing and geospatial technology are fairly recent tools on the management scene, there are innumerable potential uses that managers and decision makers are considering. Like other types of information, geospatial data production should be coordinated, detailed, affordable, accurate and consistent at all scales and for various layers (e.g. sediments, currents, tides, sensitive habitats) (CSO 2004; NACo 2007; NOAA CSC 2007; 2008b; Desotelle Consulting et al. 2006b). The Federal Government is involved at a high level, and has developed a Geospatial Line of Business (GLoB) Presidential Initiative designed to coordinate production, maintenance, and use of geospatial data. This initiative will ensure sustainable participation from Federal partners and establish a collaborative model for geospatial-related activities and investments (EGov 2008).

### 12.4.1 Uses

Reports commonly note that remote sensing technology and GIS are critical to management, and their use should continue (NOAA CSC 1996; 2002a; 2002b; CSO 1999; MCPI 2005; EGov 2008). Of groups using remote sensing technology, over 90% use geographic information systems (GIS) as opposed to other special purpose software (NOAA CSO 1999). In order further develop the field, reduced government costs, and improves services to citizens, the GLoB Presidential Initiative aims to optimize and consolidate Federal geospatial-related investments (EGov 2008).

To date, common applications of GIS data include

- Collecting baseline data
- Mapping impacts
- Mapping, monitoring, and restoring habitat
- Managing and planning land use and watersheds
- Monitoring water quality
- Managing fisheries
- Tracking invasive species
- Forecasting weather
- Conducting ocean observations
- Planning for hazard resilience
- Siting energy facilities
- Managing public access (NOAA CSC 1996; 1999; 2002b, NOAA 2008b; NOAA OCRM 2006; NOAA 2008a)

Mapping data can serve a variety of administrative purposes, including

- Supporting grant proposals and fundraising appeals
- Viewing/analyzing important resources for protection
- Producing maps for stewardship, public outreach, and education activities (MCPI 2005)

A specific application of remote sensing is the NERRS System Wide Monitoring Program (SWMP), which uses GIS to track and evaluate changes over time in coastal and estuarine habitats, and monitor land use in watersheds. NERRS and NOAA's Coastal Services Center support remote sensing and geographical information system (GIS) tools, training, and development programs within the reserve system. In one current example, GIS is being used in Connecticut to determine recreational boater behavior (NOAA CSC 2008g).

### 12.4.2 Needs

As with other data types, access, collaboration, outreach, education, and funding are necessary for successful application of remote sensing and GIS data. Because cross-agency coordination of geospatial activities can identify, consolidate, and reduce redundant geospatial investments (E Gov 2008; NACo 2007), collaboration among different agencies and groups – government, for profit, non-profit and industry groups alike – is imperative (NACo 2007; MCPI 2005).

Managers, as well as general public, particularly in rural communities, need more education about how to apply geographic information system data (NOAA CSC 2002a; 2007; NACo 2007; MCPI 2005). Additionally, different tools need to be developed for different audiences (NACo 2007). For example, one tool for the non-technical audience is a participatory GIS tool that allows users to see various scenarios on a map and change components at will (NOAA CSC 2008g).

In general, the needs identified varied with the expertise of the user. Avid GIS users identified as priority needs:

- Digital parcel data

- Aerial and satellite imagery
- Identification and mapping of priority habitat areas and public access locations

Priorities identified by resource managers not trained in GIS included training on

- How to use GPS
- How land trusts can benefit from GIS analysis and maps
- How to create maps for reports and proposals
- How to integration GPS data onto a map
- How to access to internet mapping services (MCPI 2005).

At a very simple level, a baseline understanding of existing (GIS) capacity and the utility of GIS technologies in conservation is a crucial need (MCPI 2005). Additionally, using GIS to create maps, define boundaries, and identify resource locations is an ongoing process that continually needs updating and refining (NOAA CSC 2002a).

More complex needs for GIS data include

- Using remote sensing of landscape patterns and fine-scale mapping of habitat classification to identify at-risk ecological communities, to track the extent of non-native plant invasion, and to monitor the condition of riparian areas
- Helping to resolve conflicting land use policies
- Linking land use decisions with coastal management
- Linking hazards with land use
- Helping to explain permitting
- Providing information for court cases
- Showing how communities can recover after disasters
- Demonstrating the relative costs of building in disaster-prone areas
- Supporting assessments of shoreline changes with annual, full coastal LIDAR (Light Detection and Ranging) coverage and high-resolution bathymetry (e.g. shallow water-penetrating LIDAR) data (Heinz Center 2006; CSO 2004; 2007; NACo 2007; NERRS 2008)

## 13 Coordination and Integration of Resources

In addition to gaps in data, we also treat insufficient communication and collaboration as a gap. While many resource managers have identified the need for increased capacity and resources for improved planning and management, the funding for those increases is difficult to obtain. Increased coordination, however, can serve as a proxy by helping managers pool resources within the greater management community. Furthermore, coordination between agencies is called for in planning, management, conservation efforts, and data collection, not merely to optimize resources in the form of staff, timing, technical expertise, and funding, but also to provide the inter-jurisdictional integration between data sets and management plans required for successful coastal management.

## 13.1 Coordination Challenges

Efficient coordination among coastal and marine agencies requires both access to shared data, and access to the tools and information required for planning activities (NRC 2004; NRS 2006; Desotelle Consulting et al. 2006a; Surfrider 2008). By sharing resources and coordinating planning activities, agencies could jointly design solutions for shared access, such as a web portal (NRC 2004; NERRS 2006; NRS 2006). Cross-jurisdictional coordination also requires integration of planning and implementation efforts (NOAA CSC 2002a; CSO 2007). Such cross-jurisdictional efforts may face barriers such as unwillingness or inability to field extra work and fear of losing autonomy (Heinz Center 2006).

The scale of inter-agency coordination needed to enable multi-agency or multi-state integration of activities will require

- Effective management
- Leadership
- Improved communication
- Potential changes in infrastructure (Heinz Center 2006; NCCOS 2007; NRC 2004; NSGIC 2008a; 2008b; NCCR 2008; CSO 1999; 2007)

Integration at all levels will be required for implementation of EBM (NCCOS 2007). Effective coordination will also require open, transparent communication and stakeholder engagement at all stages of each initiative (NOAA CSC 2008b). Stakeholders must be involved early and at each of the project's stages:

- Identification and definition of issues/initiatives
- Planning and development
- Completion
- Dissemination and use of information/integrated products(Weisberg et al. 2007)

## 13.2 Coordination Methods

Coordination and integration of activities will require many different methods. Some challenges to coordination can be overcome with

- Communication
- Clearly defined roles in collaboration
- Adequate funding
- Commitment
- Leadership
- Upper level support (NRS 2006; NSGIC 2008a; 2008b)

Efforts involving many different stakeholders in strategic planning will require an interdisciplinary approach (NERRS 2006; NCCOS 2007; NSGIC 2008a; 2008b; NOAA NSG 2008; NOAA CSC 2008b). Some recommended approaches that have been used in past coordination efforts include

- Establishing a clearinghouse for shared data
- Creating facilitation tools to transform data and information into standardized formats

- Employing specialists to facilitate communication among groups
- Providing for the ability to contract when skills must be sought outside of established networks (NRS 2006; NCCOS 2007; NSGIC 2008a; 2008b)

Overall, sharing advice on techniques used for effective coordination efforts is useful (Matso et al. 2008).

Coordination efforts will involve expanding and strengthening networks through approaches that have proven successful

- Resource sharing
- Workshops
- Provision of access to data and information
- Coordinated planning activities
- Collaborative projects
- Peer review of network participants' work (TNC 2008)

Capacity building exercises working toward regional collaboration will inevitably strengthen networks and ease future collaborative initiatives (NRS 2006; TNC 2008).

Standardized information gathering techniques should be established (CSO 2007; NRC 2004). Coordinated and strategic planning efforts will help optimize approaches to collecting, measuring, and reporting data and information (Heinz Center 2006; NERRS 2008). Creating tool kits for facilitating the transformation of varied data and information and disseminating them among collaborating organizations can also further standardization efforts (NRC 2004).

# 14 Concluding Remarks

This literature review compiles the primary issues and needs identified in 57 sources. Collectively, these sources provide an in-depth assessment of the coastal management community. Documents types include survey results, strategic plans, needs assessments, white papers, program evaluations, and research reports. The breadth and variety of documents reviewed reflects myriad of needs of the resource management community and the challenges it faces.

This literature review represents a preliminary step in characterizing trends in the principal needs and issues of coastal mangers. The main functions of the literature review are to identify gaps in the current body of knowledge and to inform the next phase of the project: a systematic review of existing information. By identifying communities in need of support, successful information collection methods, target audiences, and general needs this review, combined with the subsequent meta-analysis, will inform the development of the Center's customer survey as well as products and services for coastal managers.

There is a resounding need for coordination and communication across resource management entities. The Coastal Services Center's unique position could give it the opportunity to serve as a coordinating entity, particularly through its regional initiatives.

The products and services that the Center provides are invaluable, and the Center can enhance them by working to connect their customers with each other.

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